World Sustainable Energy Days
27 February – 1 March 2019, Wels/Austria

MOEEBIUS

Advancing the capabilities of energy simulation tools

Modelling Optimization of Energy Efficiency in Buildings for Urban Sustainability

Project duration: November 2015 – April 2019

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Building Technologies Division
TECNALIA

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680517

- Physical energy modelling of buildings and districts
- MOEEBIUS Distributed Energy Resources Models Library
- Reasons behind the energy performance gap
- The MOEEBIUS gap reduction way
- MOEEBIUS Building and District Energy Performance Simulation tools
- Utility and real-life enviroment applications

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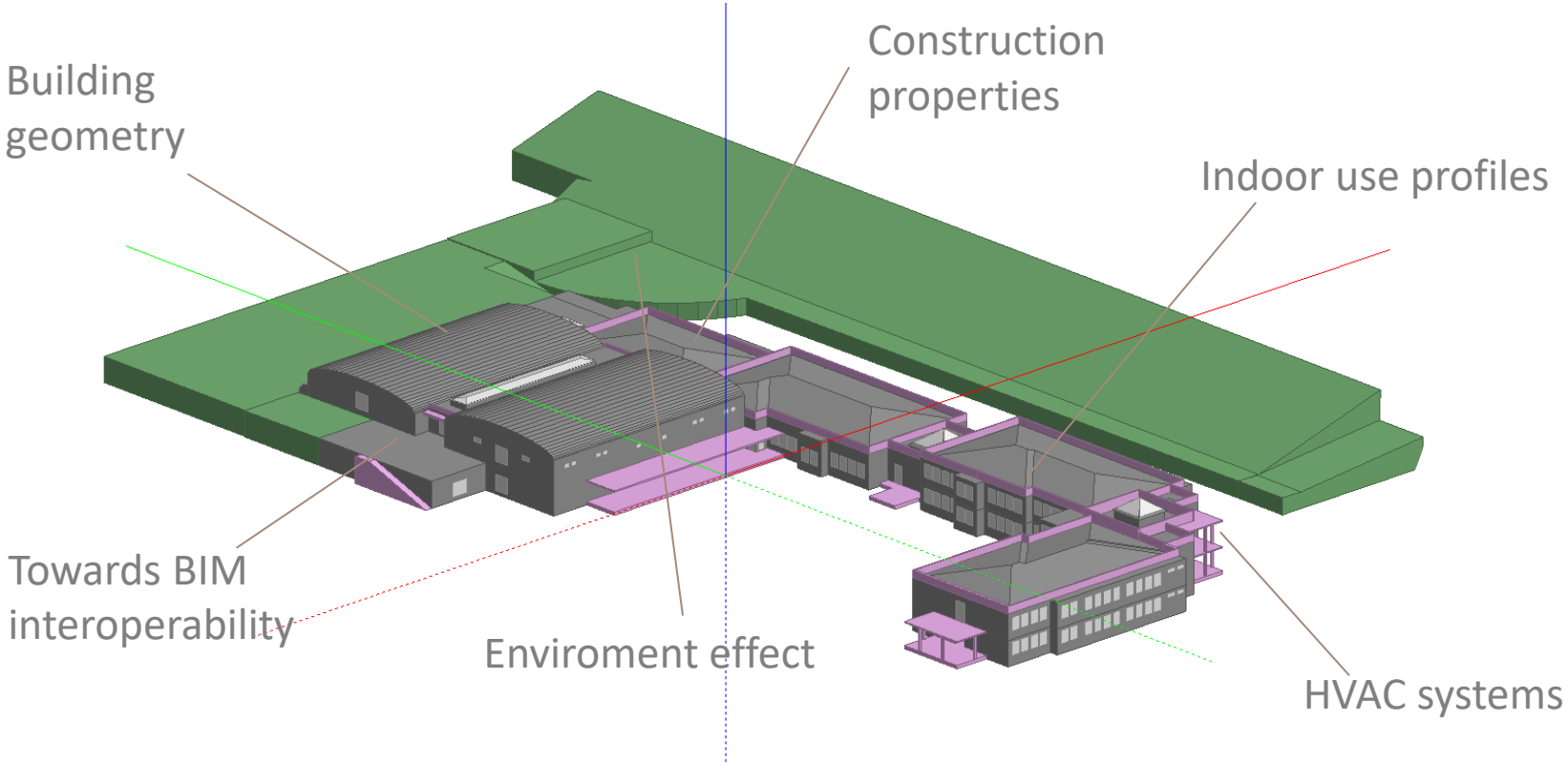

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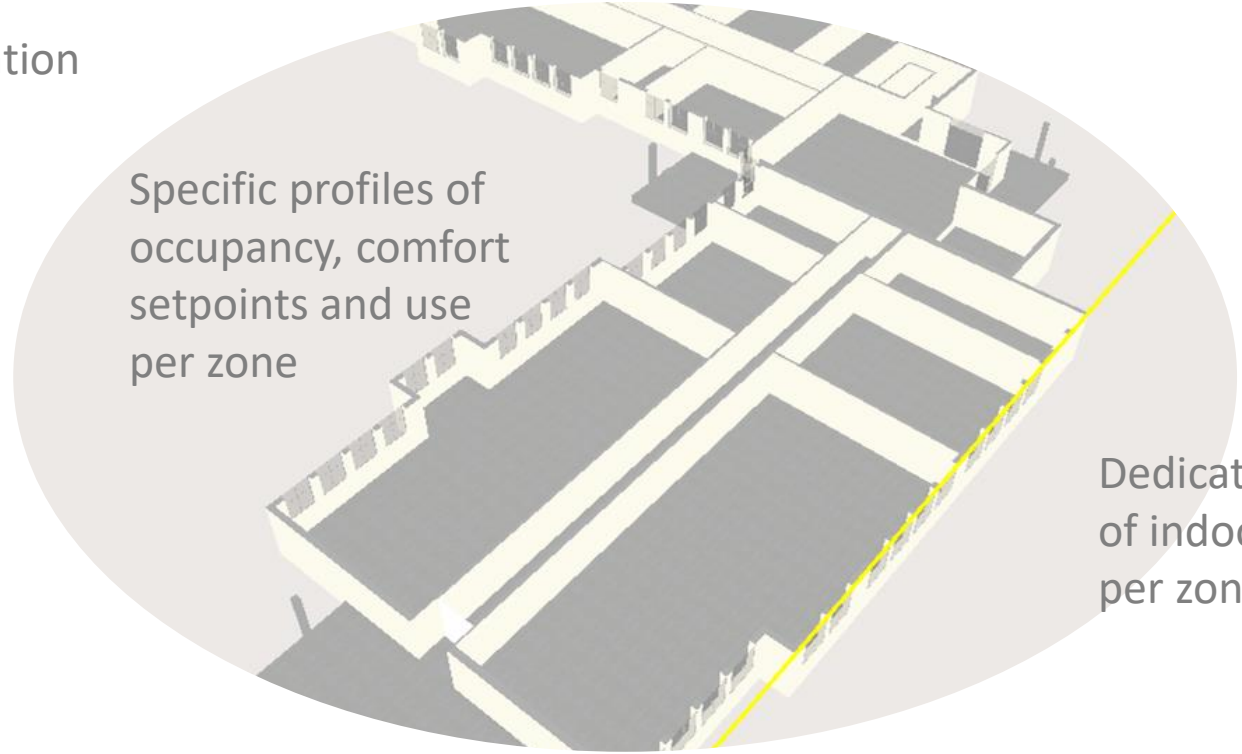
Indoor zonification



Specific profiles of occupancy, comfort setpoints and use per zone

Dedicated analyses of indoor conditions per zone

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Dynamic simulation for changing conditions

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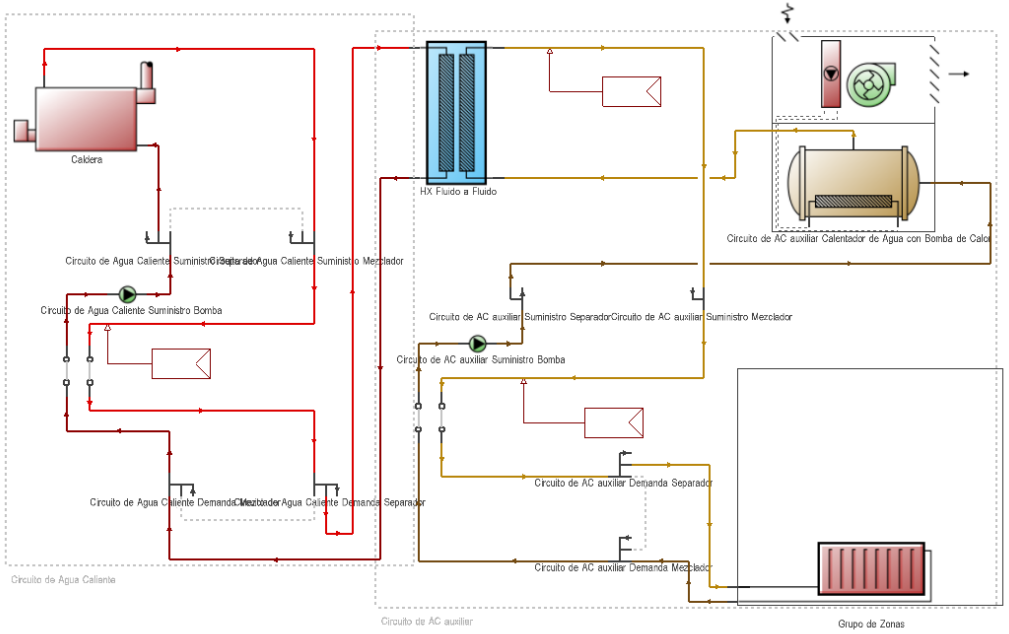
HVAC systems are completely modelled, from generation equipment characteristics, to distribution topology and the terminal units.

Generation and consumption are simulated coupled and simoultaneously.



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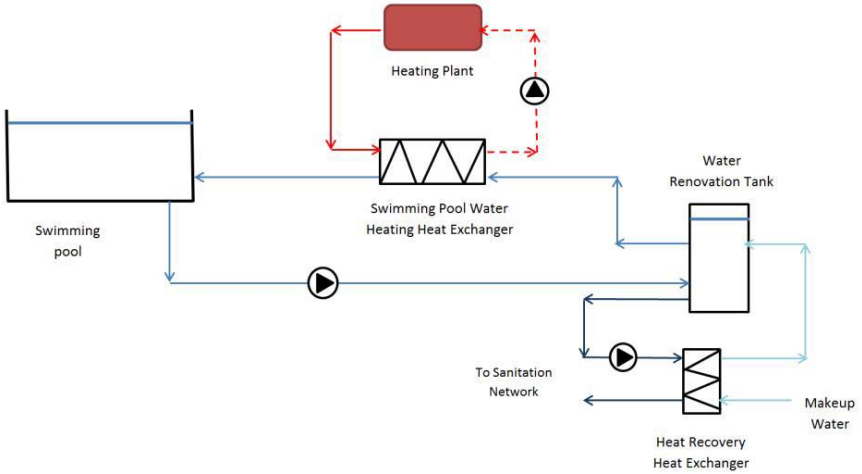
Simulations at building level use EnergyPlus as calculation engine, while the district models are developed in Modelica.

Modelica is a multi-domain computer language for complex systems modelling.

A MOEEBIUS library of specific DER and load models has been developed

The models cover the needs of the MOEEBIUS pilots, but go beyond their needs, including additional subsystems. The models are generic and adaptable to any future use or replication of MOEEBIUS modelling works.



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A MOEEBIUS library of specific DER and load models has been developed

The MOEEBIUS generic models library is formed by the following subsystems:

- Load models:
  - District heating thermal loads (Building heating substations).
  - New swimming pool thermal balance model and a swimming pool heating and makeup water thermal demand model
- Generator/Storage models:
  - District heating plant including the storage subsystem.
  - Solar thermal collector plant, including solar production storage.
  - Electric DER systems (PV systems and wind turbine systems).
- District Heating models:
  - Pumping station.
  - Distribution thermal network.

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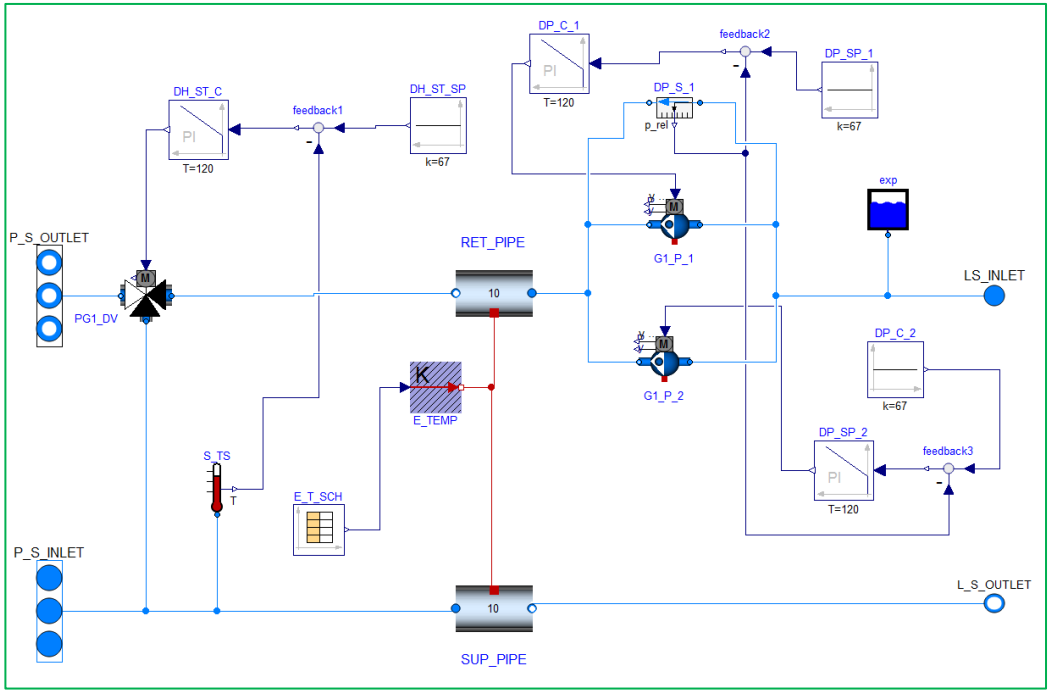
I.e. a DH pumping station is modelled using mechanical, hydraulic, thermal and control subcomponents.



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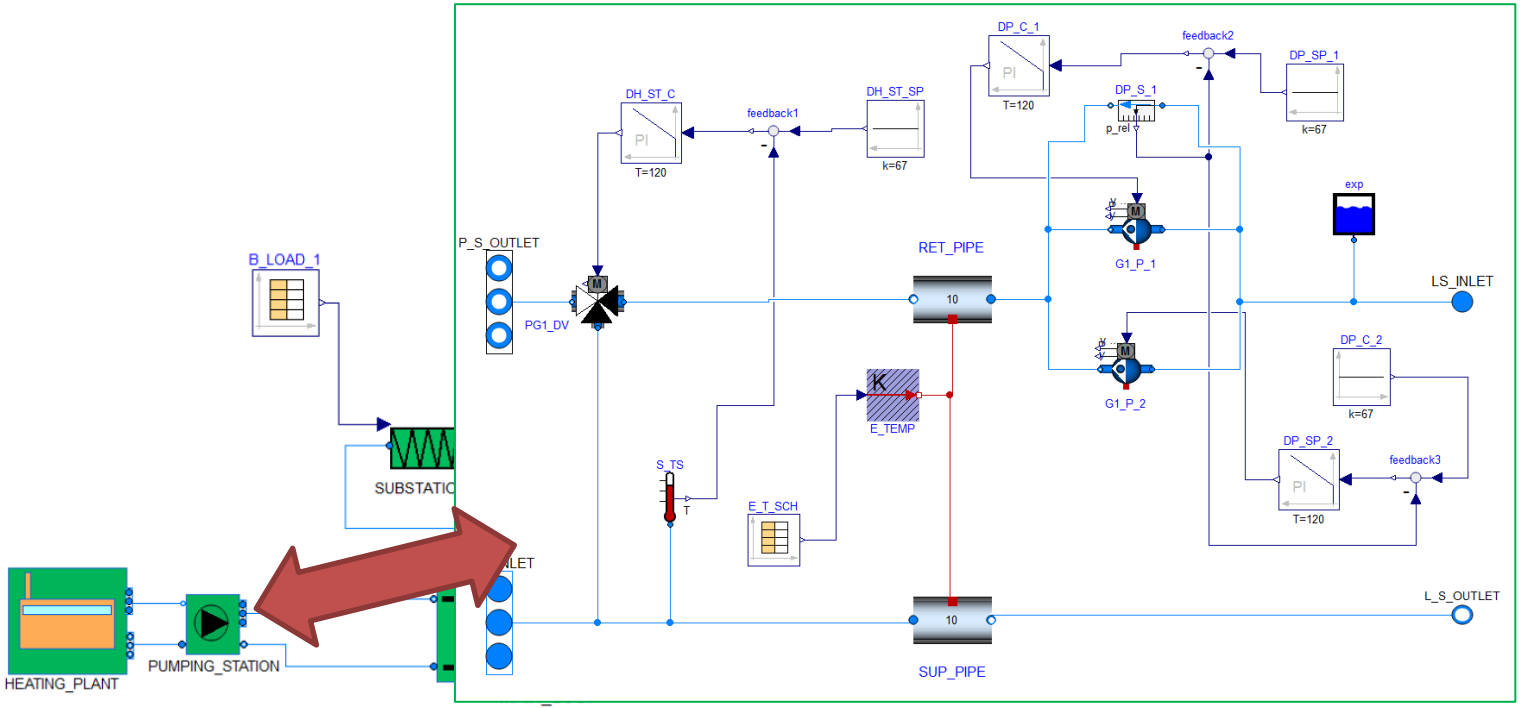
A complete District Heating grid model is composed by multiple submodels.



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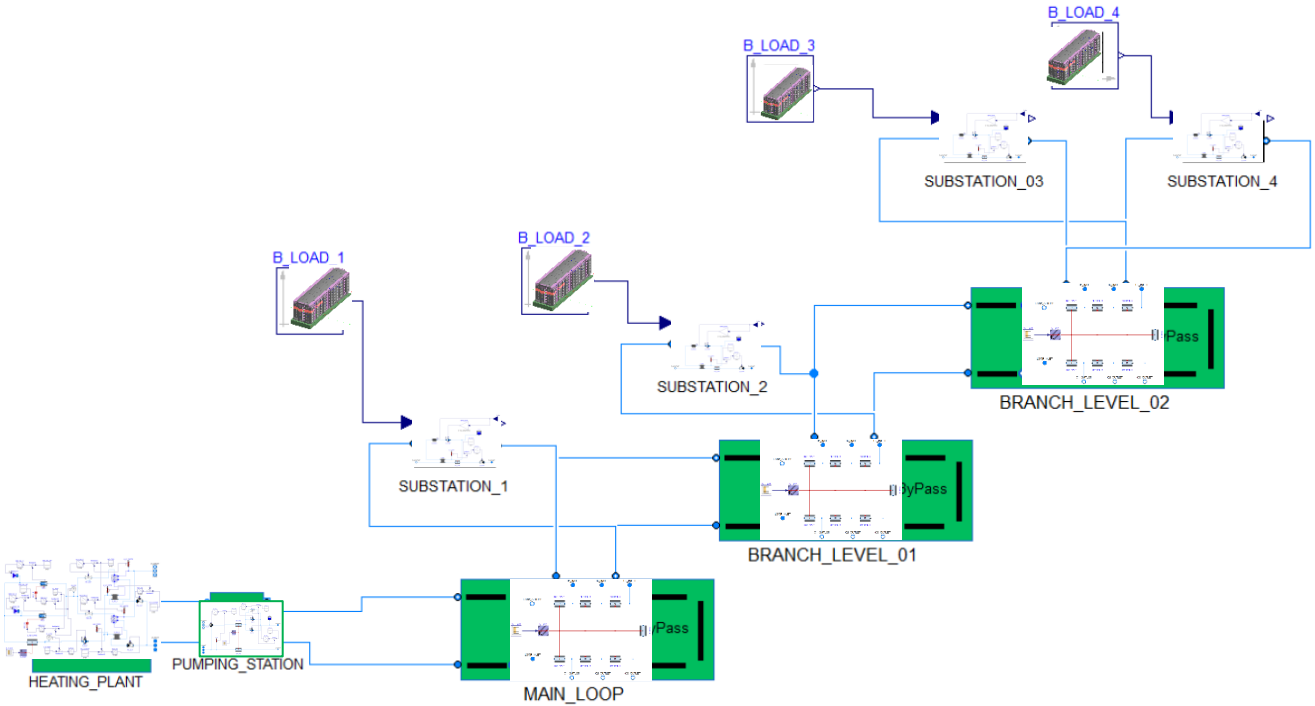

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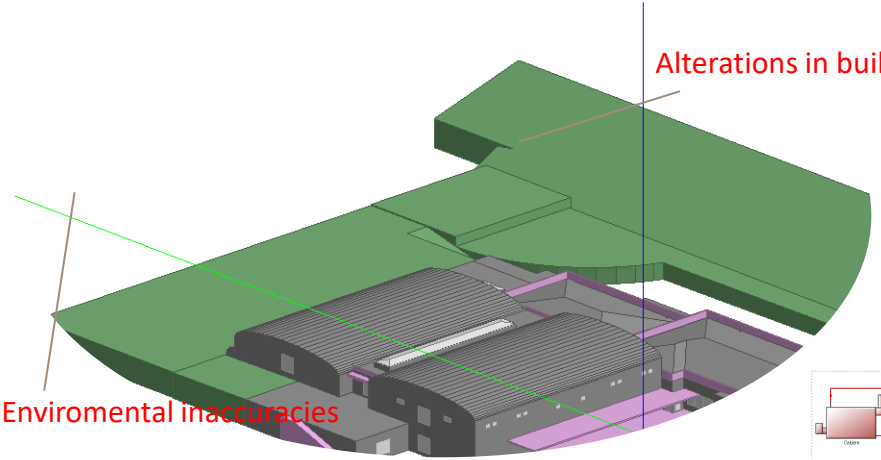
Physical buildings and districts modelling:

Details ←→ Uncertainties

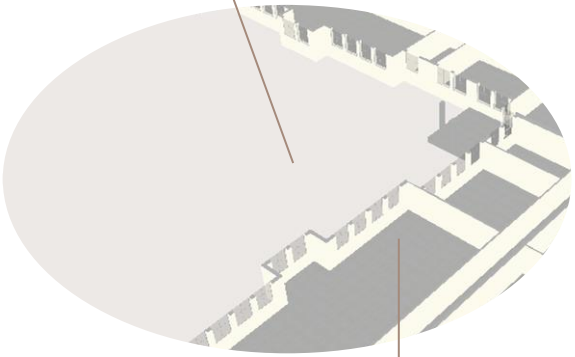
BIM inaccuracies

Alterations in buildings during life



Enviromental inaccuracies

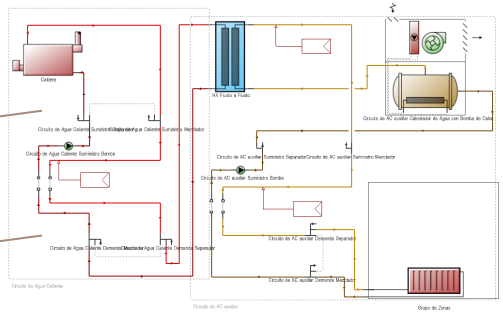
Model simplifications



Inadequate assumptions

Occupants behaviour uncertainties (setpoints, occupancy, open or closed Windows and doors…)

Non – efficient control strategies



Loss of performance

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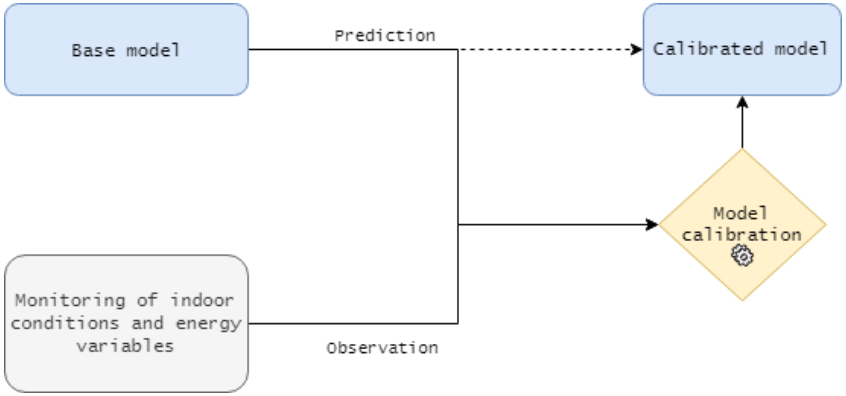
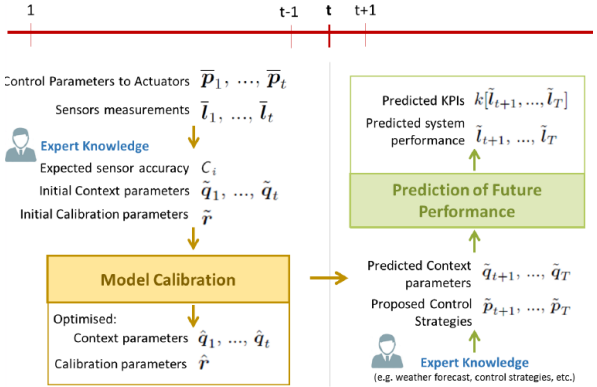
The Dynamic Assessment Engine calibrates the models, through the comparison between predicted and observed energy KPIs, and applying bayesian methods.



Models need to be automatically updated with inputs from other MOEEBIUS framework components:

- Updated occupancy and behavioural profiles
- Updated weather file based on meteorological forecast
- Calibration of model parameters (i.e. infiltration rate, thermal properties of the walls, internal gains)



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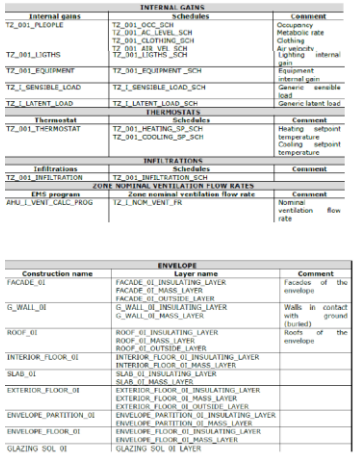
MOEEBIUS BEPS (Building and District Energy Performance Simulation tool) is a simulation server developed in the project, using EnergyPlus as simulation engine and going *business as usual* use of it.

- Model parameters standarization methodology
- Weather files generation based on forecast
- Parallel simulation of multiple scenarios
- Model's automatic modification enables:
  - Update
  - Calibration
  - Optimization
  - Retrofitting



INTERNAL GAINS		
Internal gains	**Schedules**	**Comment**
TZ_001_PLOOFLE	TZ_001_OCC_SCH TZ_001_AC_LEVEL_SCH TZ_001_CLOTHING_SCH TZ_001_AIR_VEL_SCH	Occupancy Metabolic rate Clothing Air velocity
TZ_001_LIGTHS	TZ_001_LIGTHS_SCH	Lighting internal gain
TZ_001_EQUIPMENT	TZ_001_EQUIPMENT_SCH	Equipment internal gain
TZ_I_GENSIBLE_LOAD	TZ_I_GENSIBLE_LOAD_SCH	Generic sensible load
TZ_I_LATENT_LOAD	TZ_I_LATENT_LOAD_SCH	Generic latent load
THERMOSTATS		
Thermostat	**Schedules**	**Comment**
TZ_001_THERMOSTAT	TZ_001_HEATING_SP_SCH TZ_001_COOLING_SP_SCH	Heating setpoint temperature Cooling setpoint temperature
INFILTRATIONS		
Infiltrations	**Schedules**	**Comment**
TZ_001_INFILTRATION	TZ_001_INFILTRATION_SCH	
ZONE NOMINAL VENTILATION FLOW RATES		
EMS program	**Zone nominal ventilation flow rate**	**Comment**
AHU_1_VENT_CALC_PROG	TZ_I_NOM_VENT_FR	Nominal ventilation flow rate

ENVELOPE		
Construction name	**Layer name**	**Comment**
FACADE_01	FACADE_01_INSULATING_LAYER FACADE_01_MASS_LAYER FACADE_01_OUTSIDE_LAYER	Facades of the envelope
G_WALL_01	G_WALL_01_INSULATING_LAYER G_WALL_01_MASS_LAYER	Walls in contact with ground (buried)
ROOF_01	ROOF_01_INSULATING_LAYER ROOF_01_MASS_LAYER ROOF_01_OUTSIDE_LAYER	Roofs of the envelope
INTERIOR_FLOOR_01	INTERIOR_FLOOR_01_INSULATING_LAYER INTERIOR_FLOOR_01_MASS_LAYER	
SLAB_01	SLAB_01_INSULATING_LAYER SLAB_01_MASS_LAYER	
EXTERIOR_FLOOR_01	EXTERIOR_FLOOR_01_INSULATING_LAYER EXTERIOR_FLOOR_01_MASS_LAYER EXTERIOR_FLOOR_01_OUTSIDE_LAYER	
ENVELOPE_PARTITION_01	ENVELOPE_PARTITION_01_INSULATING_LAYER ENVELOPE_PARTITION_01_MASS_LAYER	
ENVELOPE_FLOOR_01	ENVELOPE_FLOOR_01_INSULATING_LAYER ENVELOPE_FLOOR_01_MASS_LAYER	
GLAZING SOL 01	GLAZING SOL 01 LAYER	

HEATING AND COOLING GENERATORS		
Generator	**Capacity/efficiency curves**	**Comment**
BOILER_1	BOILER_1_EFF_CURVE	Efficiency curve
CHILLER_1	CHILLER_1_CAP_CURVE CHILLER_1_EPP_T_CURVE CHILLER_1_EFF_FLR_CURVE	Capacity curve Efficiency curve (temperatures) Efficiency curve (PRL ratio)
HEATING AND COOLING GENERATOR SETPOINTS		
Generator	**Schedules**	**Comment**
BOILER_1	BOILER_1_SP_TEMP_SCH	Setpoint temperature
CHILLER_1	CHILLER_1_SP_TEMP_SCH	Setpoint temperature
PRODUCTION PLANT SETPOINTS		
Plant	**Schedules**	**Comment**
M_PLANT_1	M_PLANT_1_SP_TEMP_SCH	Setpoint temperature
C_PLANT_1	C_PLANT_1_SP_TEMP_SCH	Setpoint temperature
STORAGE TANK SETPOINTS		
Tank	**Schedules**	**Comment**
TANK_1	TANK_1_SP_TEMP_SCH	Setpoint temperature
AHU AVAILABILITY SCHEDULES		
Components	**Schedules**	**Comment**
AHU_1	AHU_1_LOOP_AVAIL_SCH	AHU availability
AHU_1_SUPPLY_FAN	AHU_1_SUPPLY_FAN_AVAIL_SCH	AHU supply fan availability
AHU_1_EXHAUST_FAN	AHU_1_EXHAUST_FAN_AVAIL_SCH	AHU exhaust fan availability
AHU_1_HEATING_COIL	AHU_1_HEATING_COIL_AVAIL_SCH	Heating coil availability
AHU_1_COOLING_COIL	AHU_1_COOLING_COIL_AVAIL_SCH	Cooling coil availability
AHU_1_HR_HE	AHU_1_HR_HE_AVAIL_SCH	Heat recovery availability

51 Groups – 70 subgroups – Single values, arrays, ...

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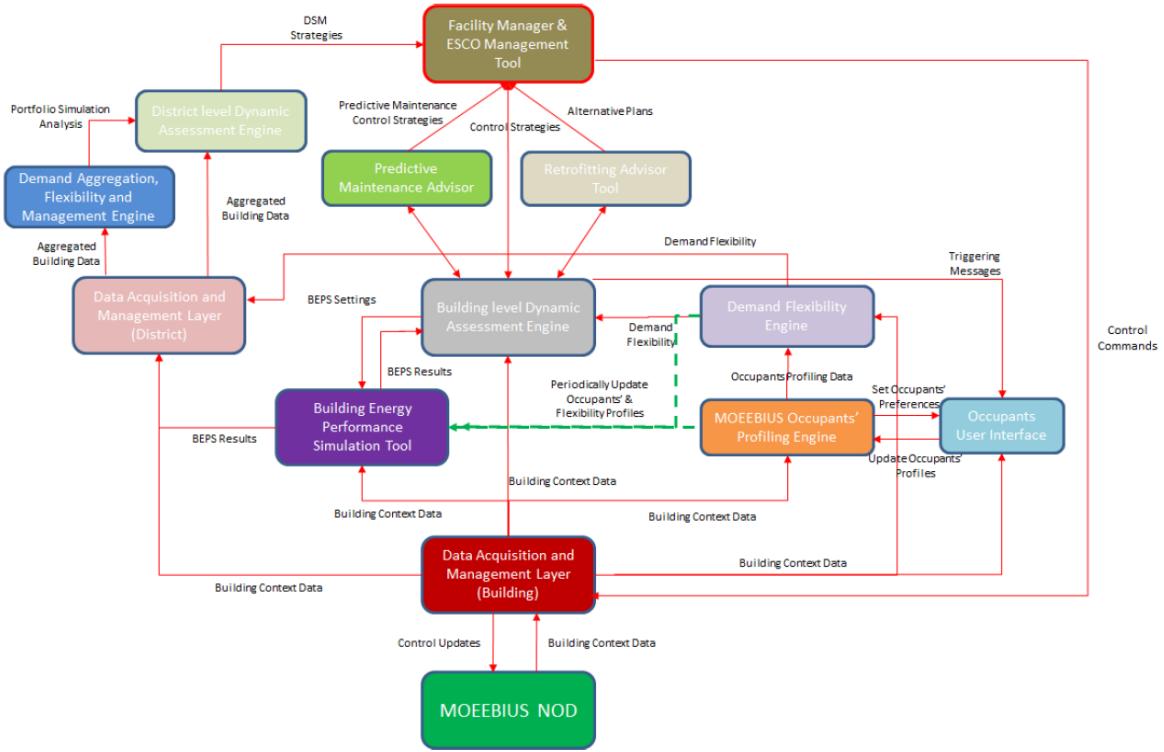
MOEEBIUS BEPS: a core component in the MOEEBIUS framework



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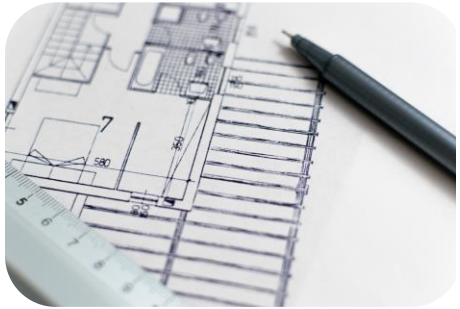
Multi-purpose modelling

One model for building's life three main phases



Design

Operation & Maintenance

Retrofitting

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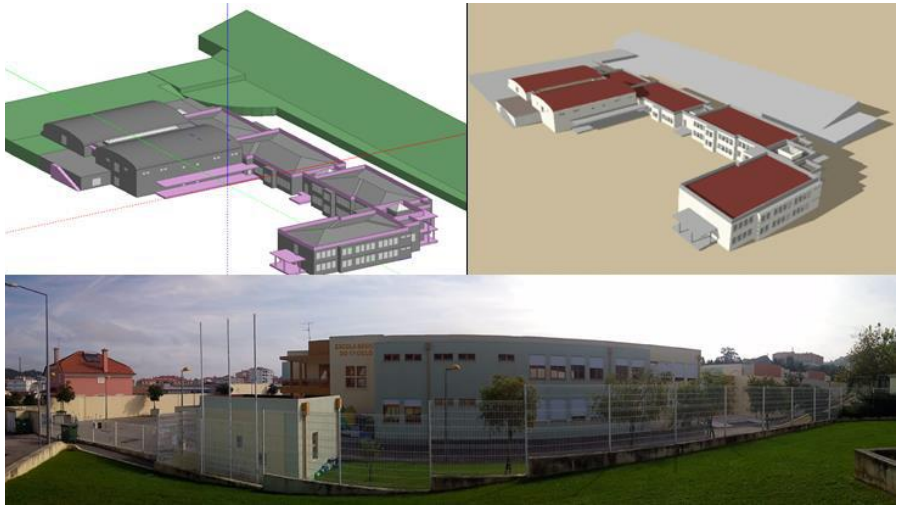
Application in the MOEEBIUS project pilot sites

Sport-educational complex in Mafra (Portugal)

- HVAC control optimization for the main thermal loads (swimming pool, sport hall, space heating,…)
- Monitoring and remote visualization of indoor comfort conditions and consumption variables
- Learning of users behavior and preferences



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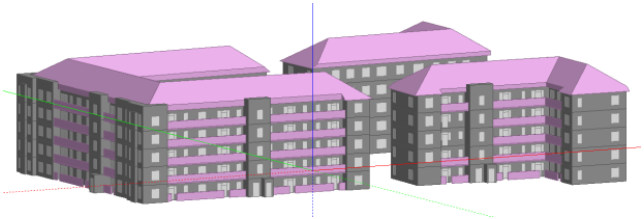
Application in the MOEEBIUS project pilot sites

3 residential blocks of apartments in London (UK)

- Analysis of domestic consumers potential participation in Demand Response schemes
- Building façade's retrofitting alternatives evaluation
- Monitoring and remote visualization of indoor comfort conditions and consumption variables
- Learning of users behavior and preferences



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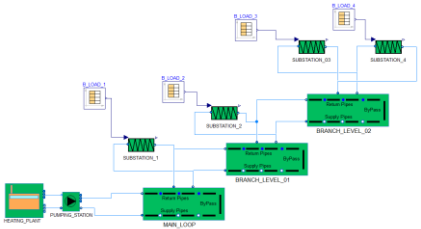
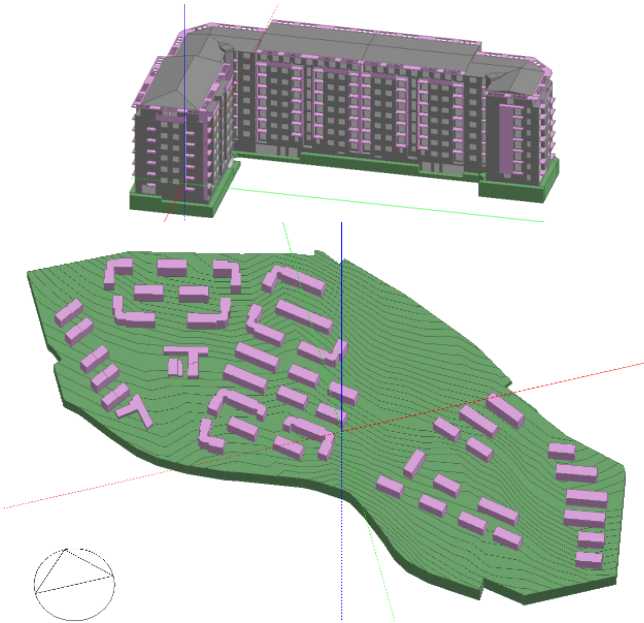
Application in the MOEEBIUS project pilot sites

44 residential (>4600 apartments) and 2 educational buildings in Belgrade (serbia)

- Remote monitoring of District Heating consumption
- Modelling and co-simulation of buildings and district:
  - Weekly prediction of consumption for the DH grid operator
  - Evaluation of alternative grid operation strategies (*digital twin*) and energy optimization, without impacting end-users comfort





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MOEEBIUS library application beyond MOEEBIUS project

Design and sizing of a District Heating and DHW grid in Madrid (Spain)

- Scaling up of an existing plant, in order to cover increasing demand
- Generation plant sizing
- Distribution grid sizing
- Building level substation design
- Definition and evaluation of alternatives of renovation for an optimized grid

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iSQ
GRINDROP Smart Homes and Living Offices
Beogradske elektrane BELGRADE PUBLIC UTILITY COMPANY
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